

Inter-annual patterns in atmospheric radiative cooling from TRMM & TERRA: Implications to the vertical water vapor distribution

Anand K. Inamdar

V. Ramanathan

Center for Atmospheric Sciences

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Key Issues in the study of Water Vapor Feedback

- Role of vertical structure of water vapor variability in the troposphere and the associated sensitivity to climate;
- Uncertainties in UTH mask the actual sensitivity to height-dependent changes;
- Broadband TOA measurements – too weak signal;
- Atmospheric column loses long wave radiative energy through emissions both at TOA and surface.

Definitions

- $$G_a = e\sigma T_s^4 - OLR$$

$$G_a^*$$

$$RC = G_a - G_a^*$$

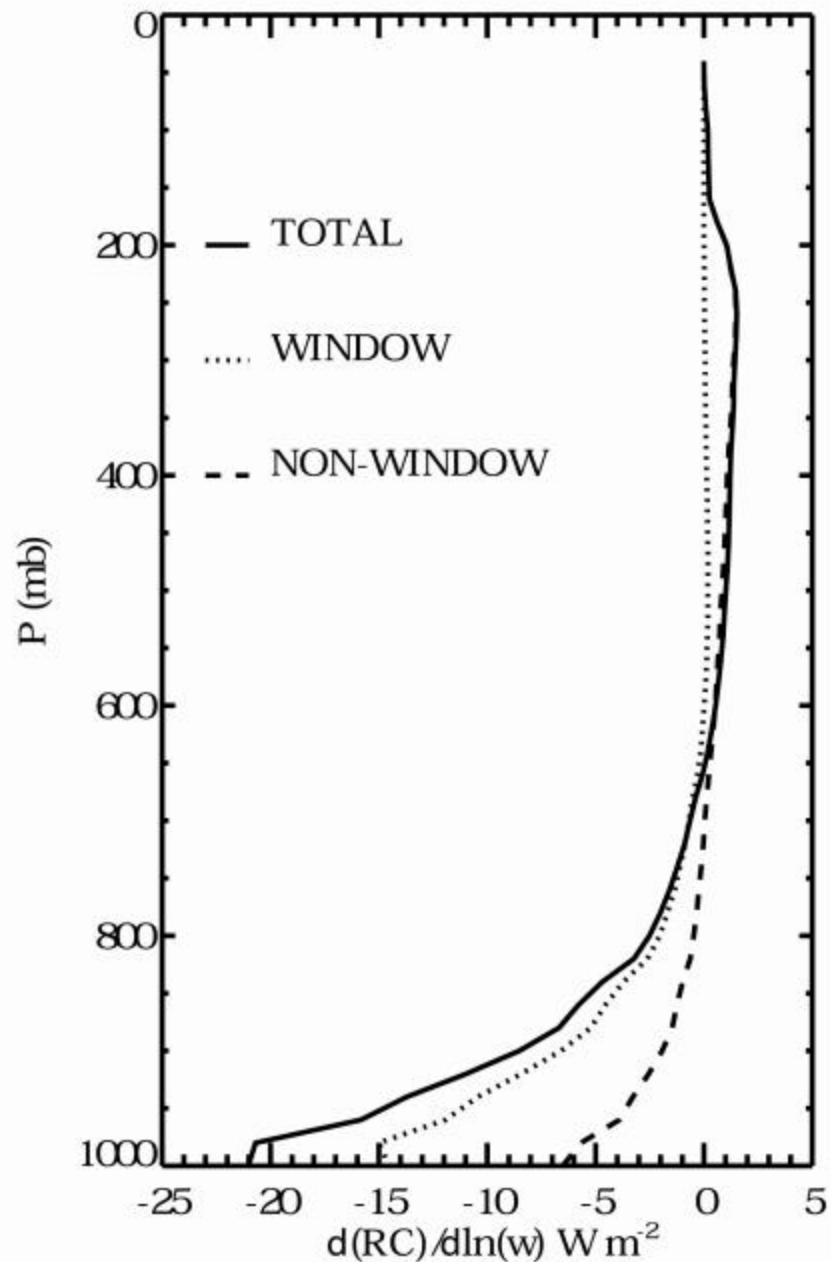
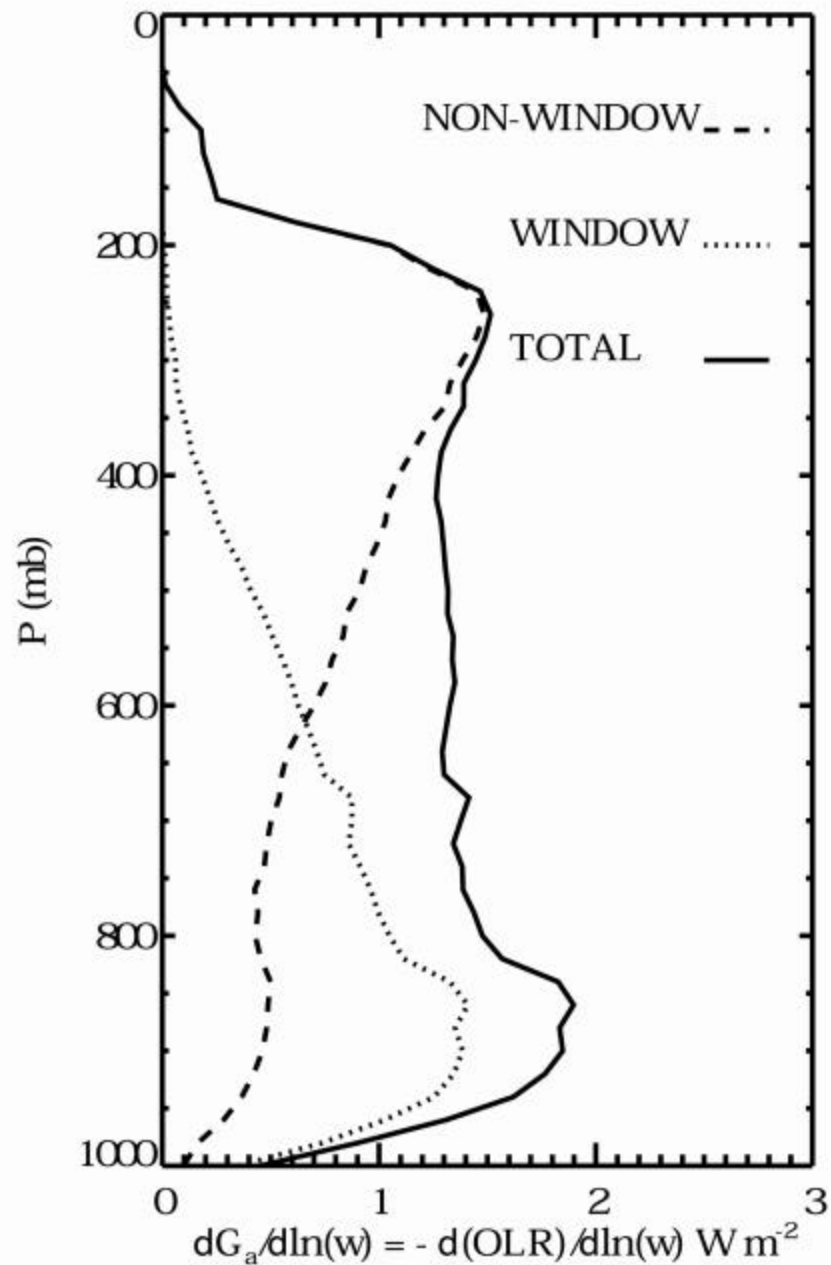
TRMM SSF Edition 2B

TERRA SSF Edition 1A (TRMM ADMs)

Ancillary Data

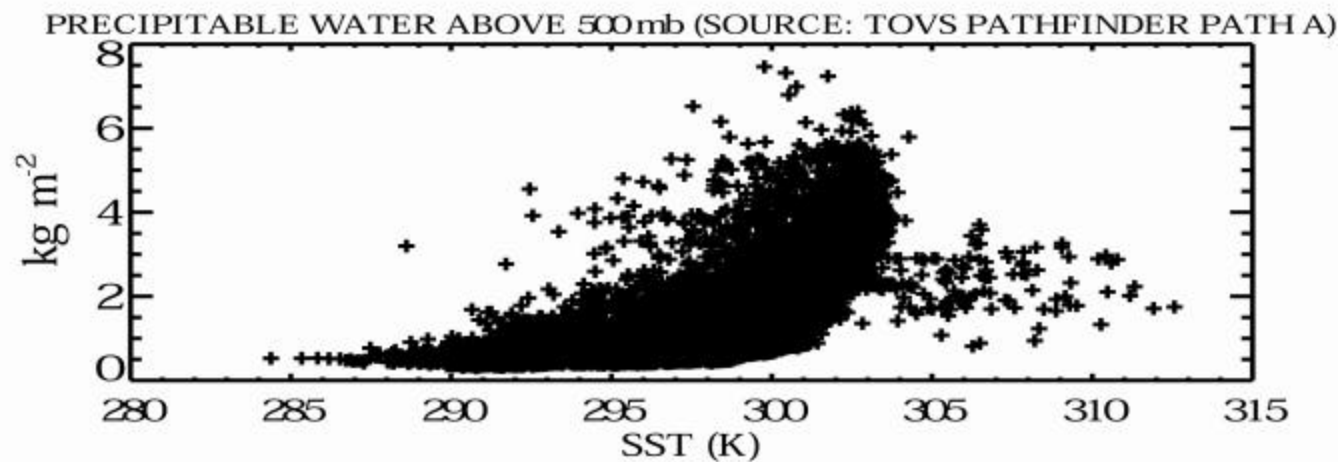
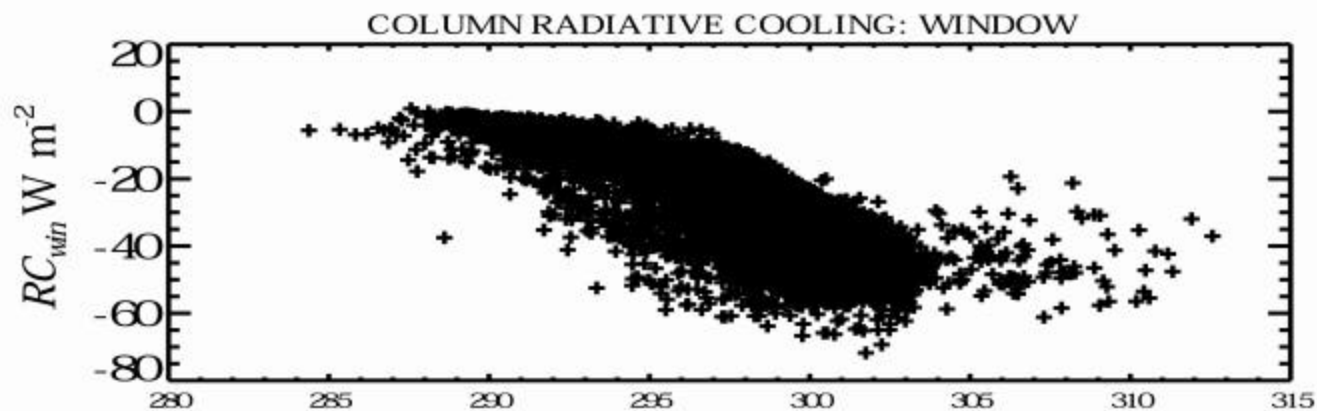
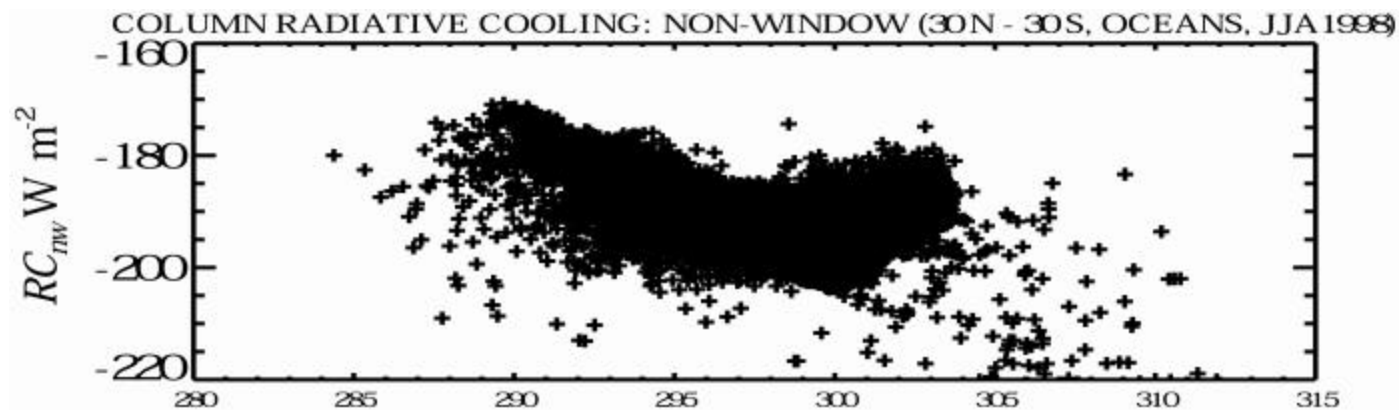
TOVS Path Finder Path-A (Susskind et al. 1997)

SENSITIVITY OF G_a AND COL RADIATIVE COOLING TO H_2O PERTURBATION

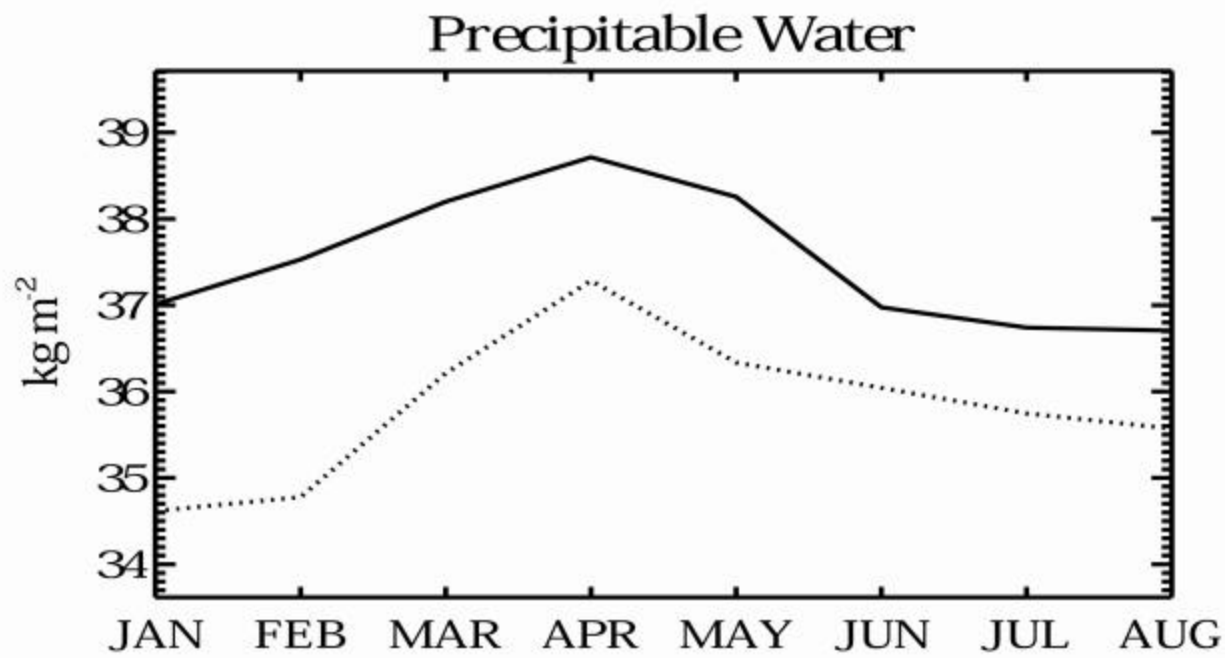
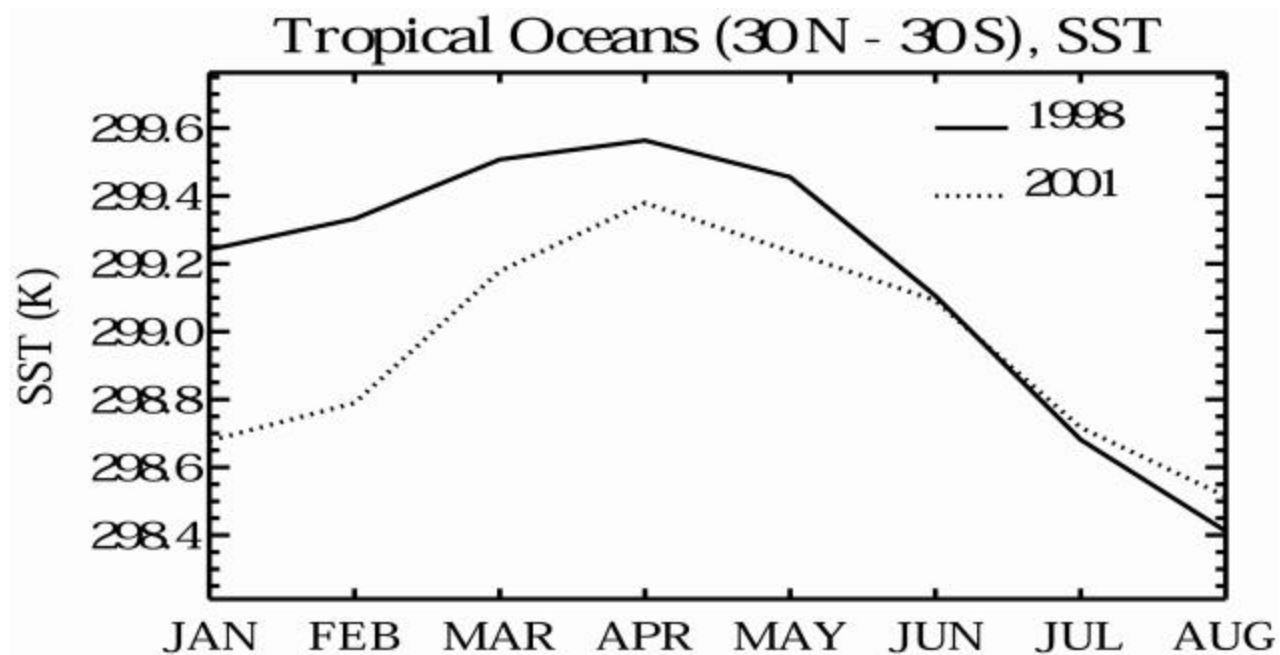


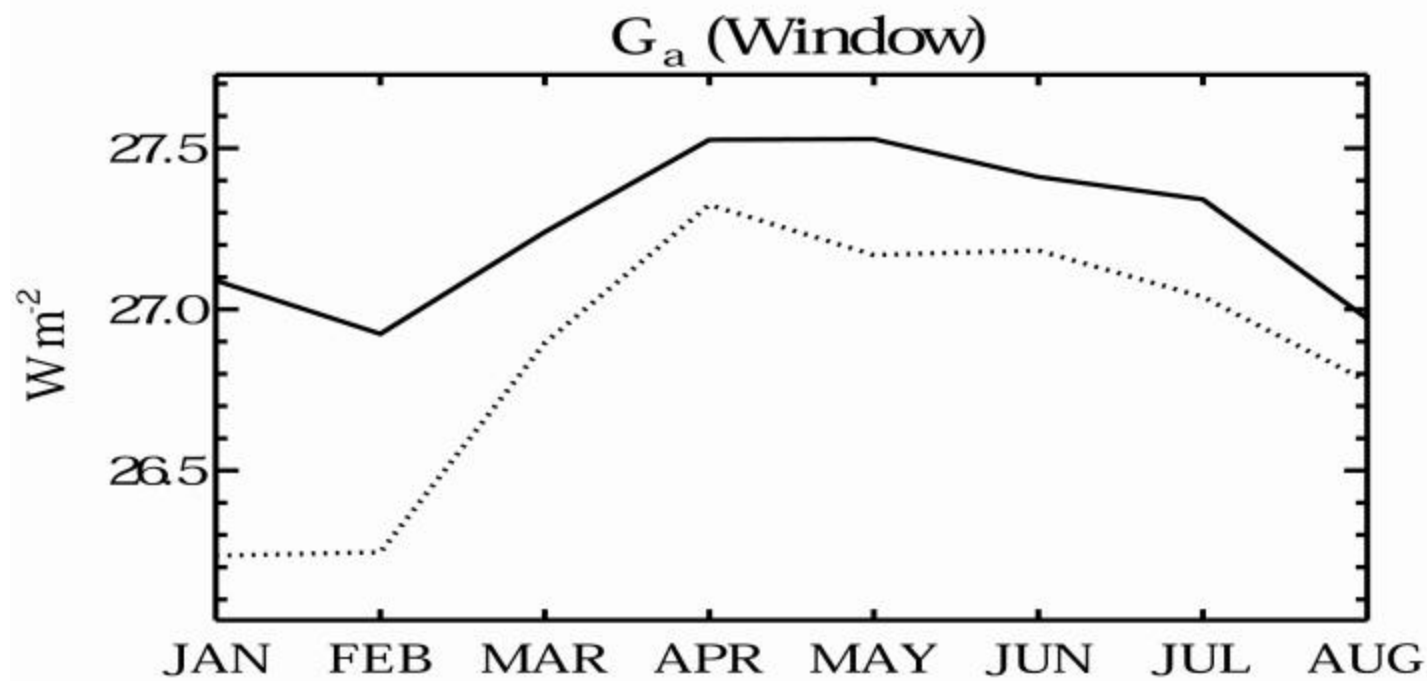
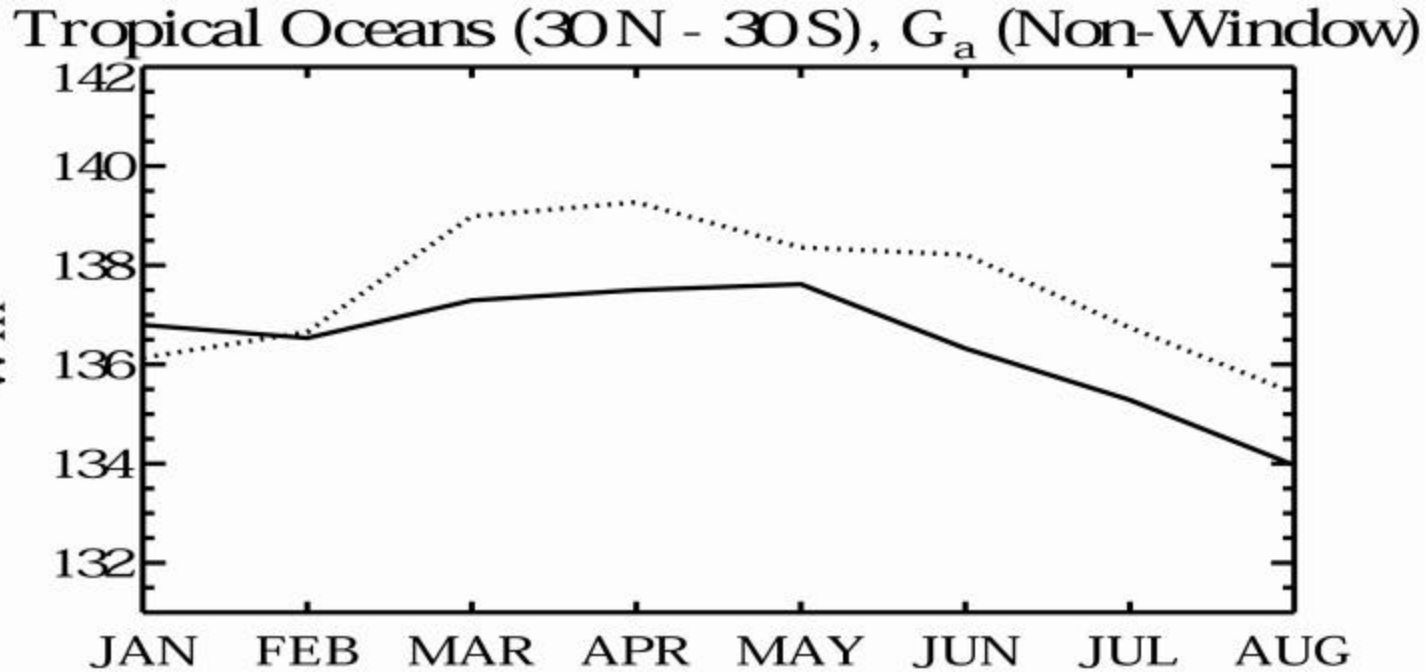
Conclusion from the Sensitivity study

- Continuum emission in the window (8 – 12 micron) contributes to enhanced cooling of the column, while elevated levels of moisture in the upper troposphere lead to a net decrease in the long wave cooling of the column owing to strong absorption in the rotational bands.

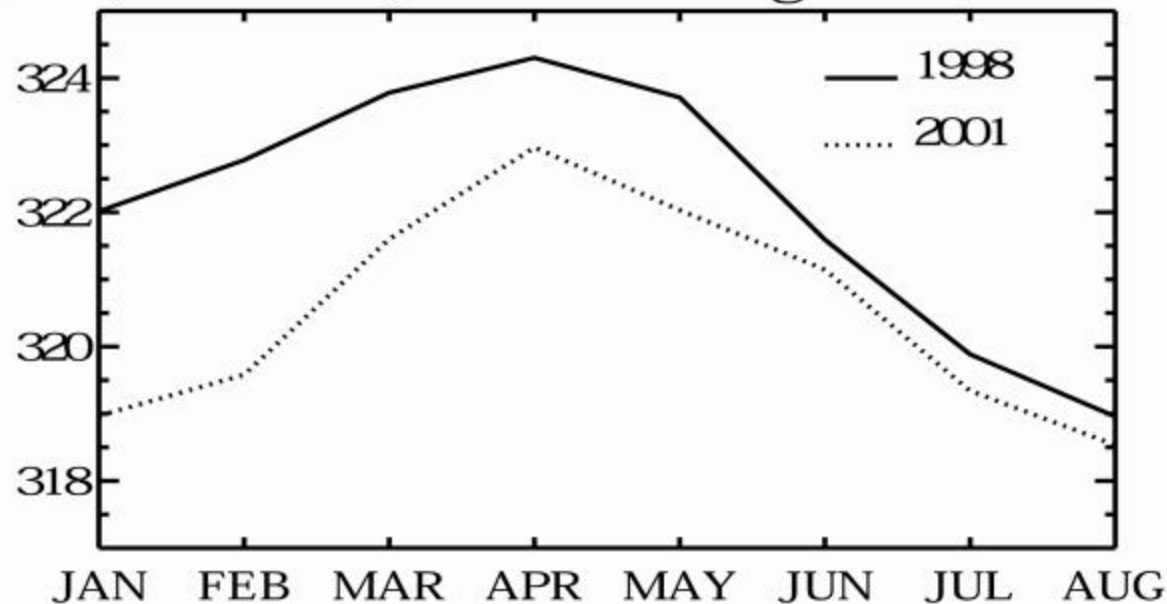


Inter-annual differences in surface temperature, water vapor and atmospheric greenhouse effect between 1998 (TRMM year) and 2001 (TERRA year) reveal some very interesting patterns.

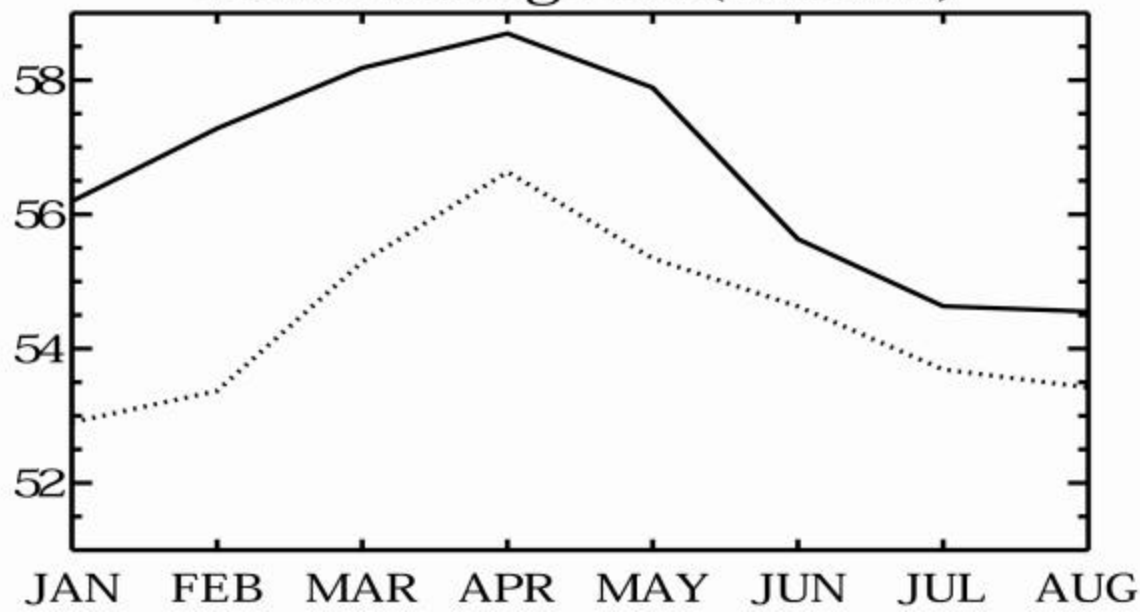




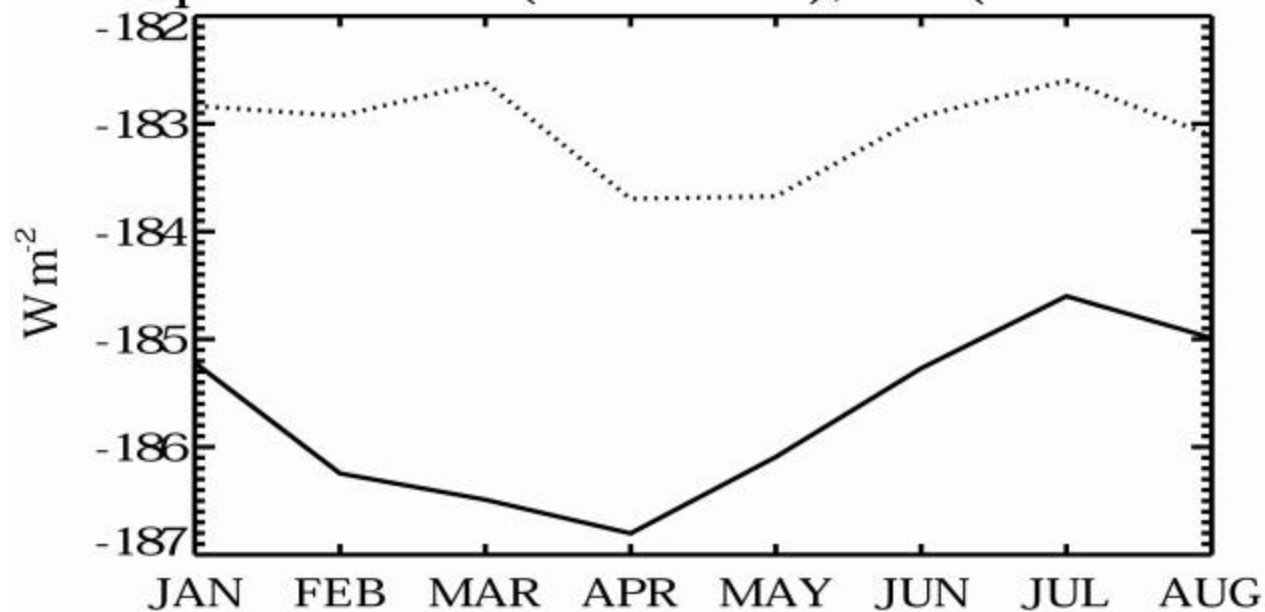
Tropics (30N - 30S): Down-welling Flux (Non-Window)



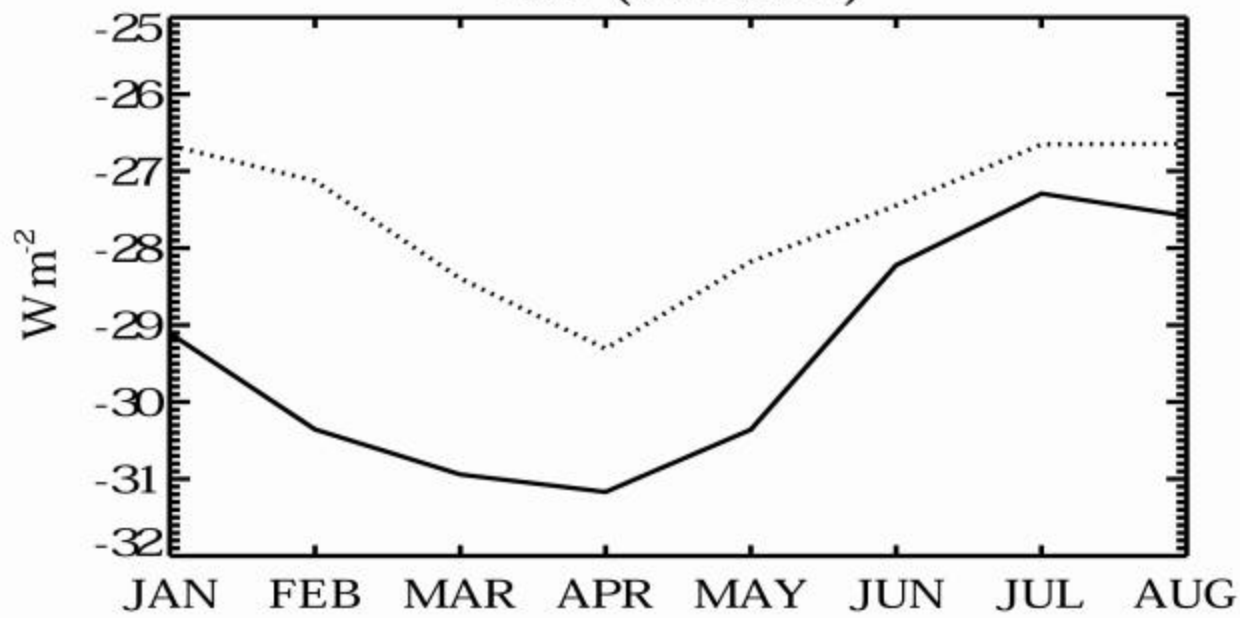
Down-welling Flux (Window)



Tropical Oceans (30N - 30S), RC (Non-Window)

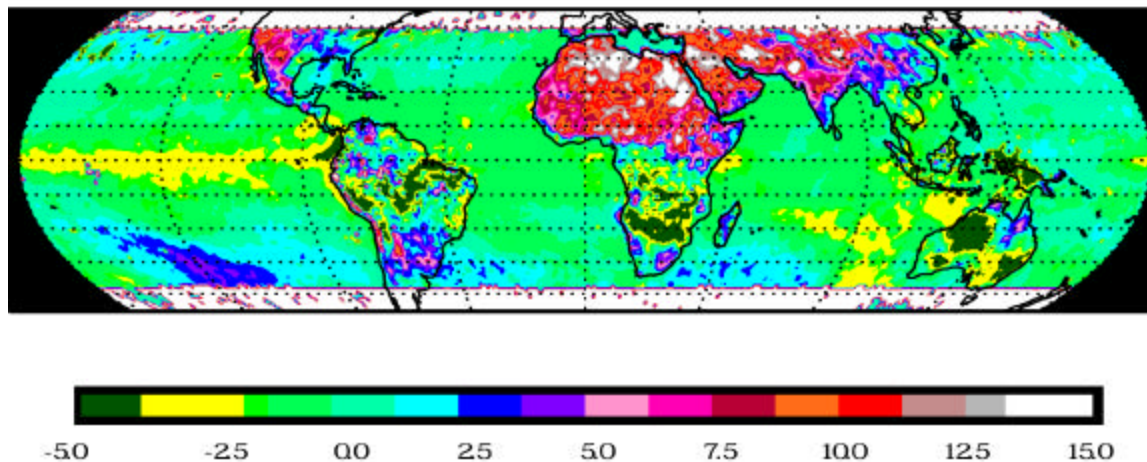


RC (Window)

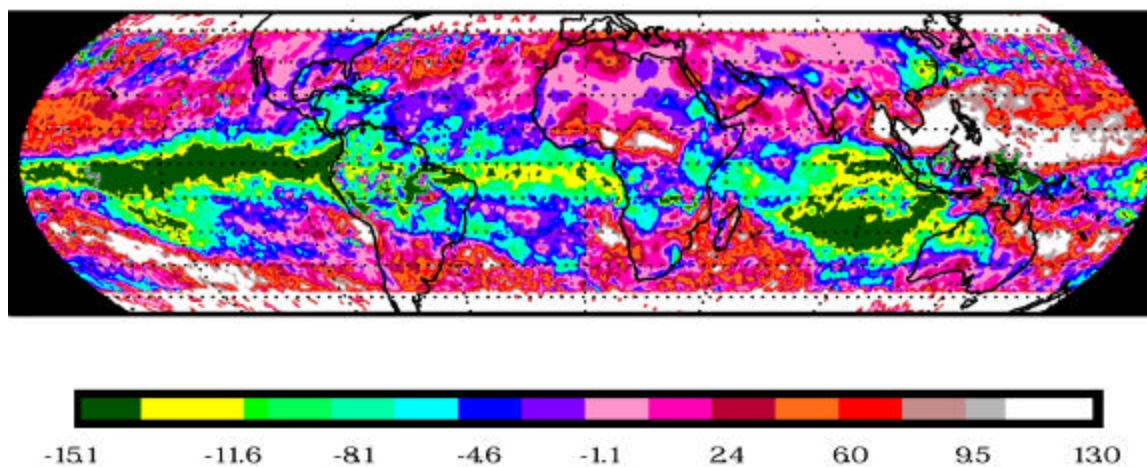


PLATFORM: TRMM (1998) & TERRA (2001)

SURFACE TEMPERATURE DIFFERENCE (K) MAR 2001 - MAR 1998

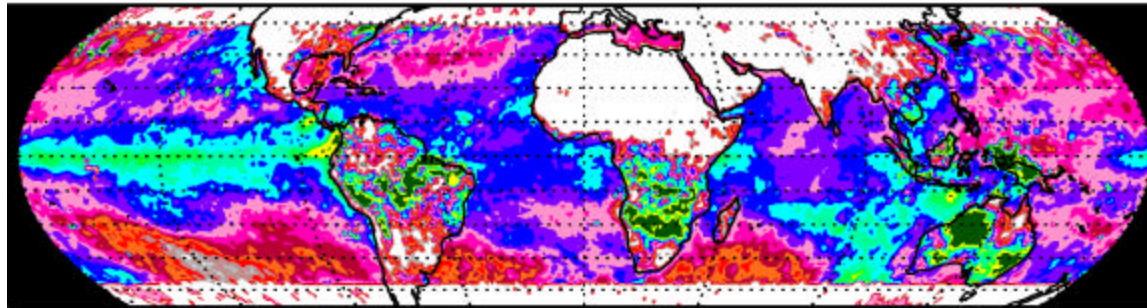


PRECIPITABLE WATER DIFF (kg m^{-2}) MAR 2001 - MAR 1998

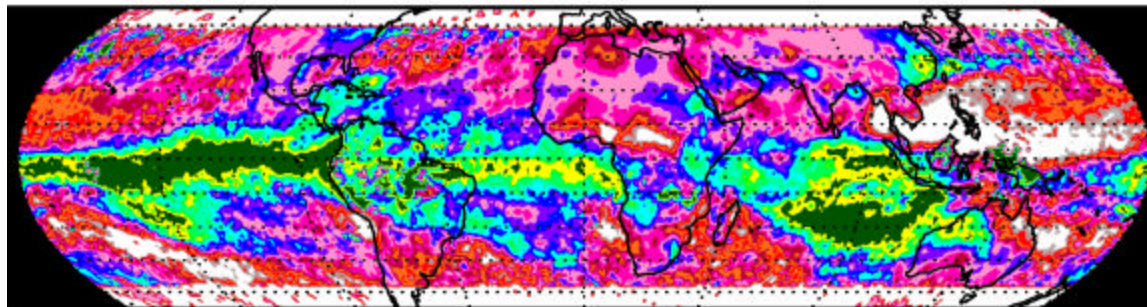


PLATFORM: TRMM (1998) & TERRA (2001)

Surface Temp Change (K) Mar2001-Mar1998

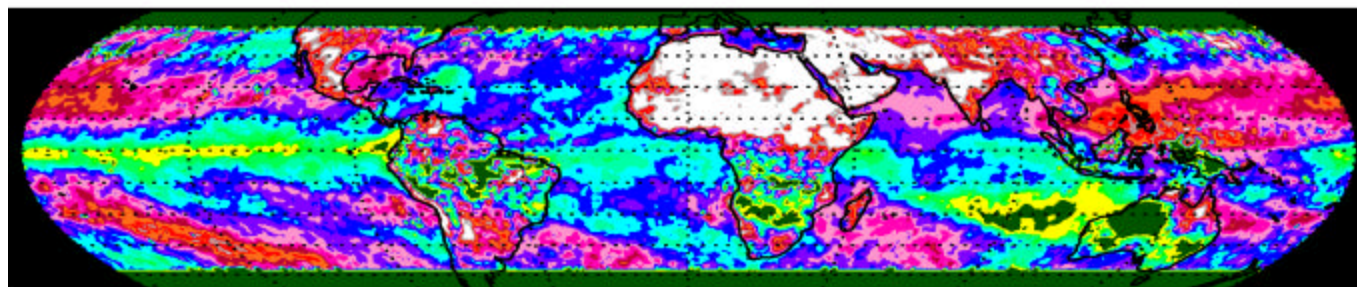


Precip Water Change (kg m^{-2}) Mar2001-Mar1998

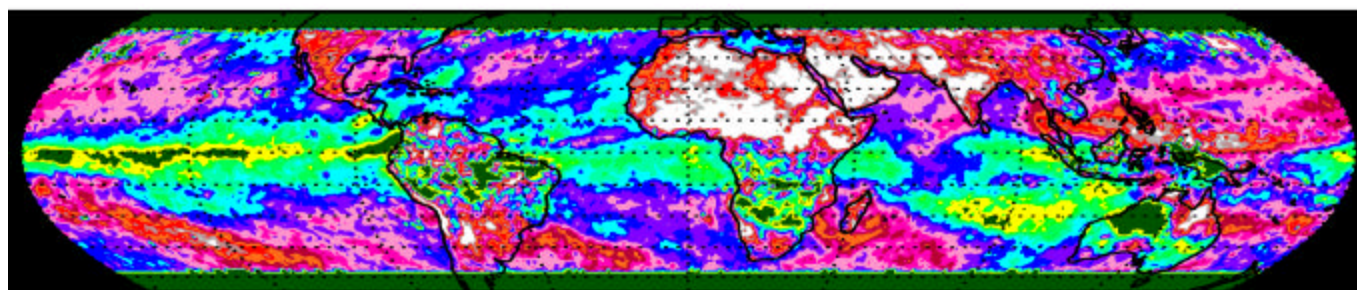


Platform: TRMM(1998) & TERRA(2001)

G_a (NON-WINDOW) Change Mar2001-mar1998

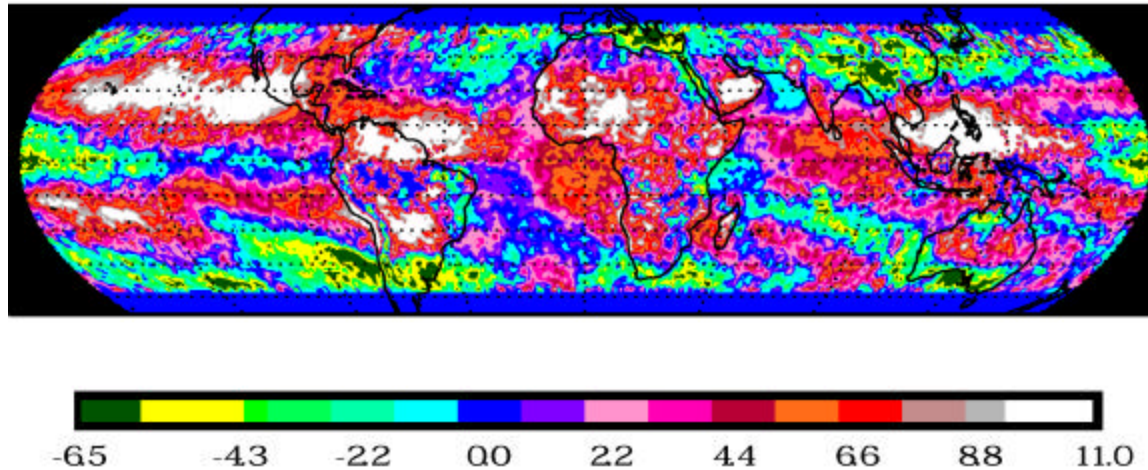


G_a (WINDOW) Change Mar2001-mar1998

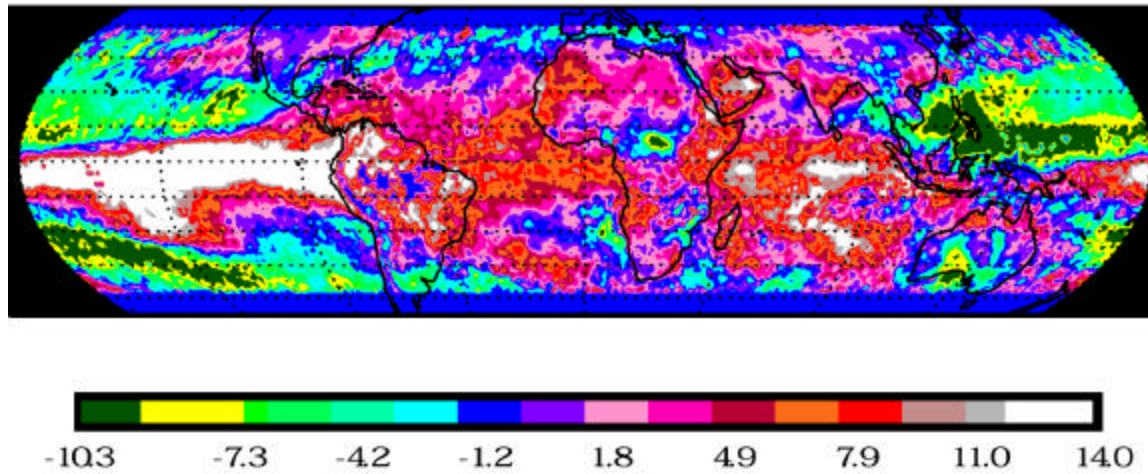


CLEAR-SKY LONGWAVE RADIATIVE COOLING (TRMM & TE

CHANGE IN RC (NON-WINDOW) JFM 2001 - JFM 1998



CHANGE IN RC (WINDOW) JFM 2001 - JFM 1998

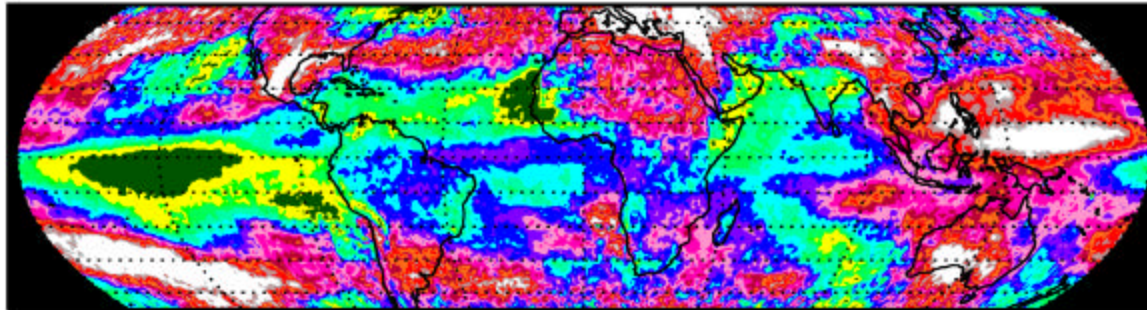


Conclusion

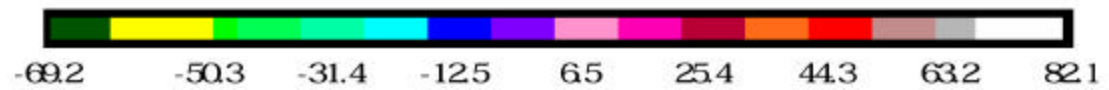
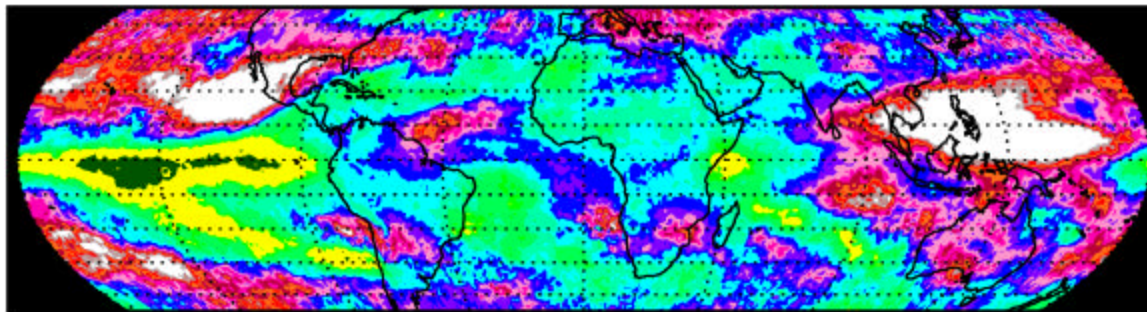
- Entire stretch of the Pacific Ocean north of equator had a moister upper troposphere in 2001 than in 1998, although domain average (30 N – 30 S) SST was cooler.
- Cooler and drier close to the equator during 2001.
- But the moister N. Pacific with increased G_a (Non-window) overwhelms.

TOVS PATHFINDER PATH A (Susskind et al. 1997)

PERCENT CHANGE IN PRECIP WATER BELOW 500mb: JFM 2001 - JFM 1998



PERCENT CHANGE IN PRECIP WATER ABOVE 500mb: JFM 2001 - JFM 1998

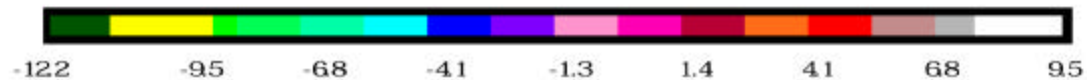
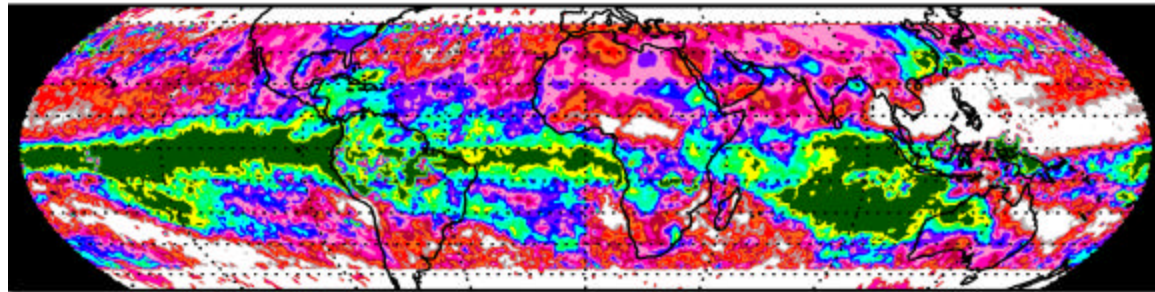


Significantly
More
variability in
UTH



WATER VAPOR PRODUCTS COMPARISON (SSF & TOVS)

PRECIP. WATER CHANGE (kg m^{-3}) MAR2001-MAR1998 SSF DATA



PRECIP. WATER CHANGE (kg m^{-3}) MAR2001-MAR1998 TOVS DATA

